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## ABSTRACT

Two experiments were designed to assess children's ability to understand recursive structures of thinking which include thinking about contiguous people, thinking about action between people, thinking about thinking, and thinking about thinking about thinking. In Experiment I, 32 second, fourth, sixth, and eighth graders were tested on eight tasks designed to assess the ability to understand recursive structures. The tasks varied on both content and logical or structural dimensions. Both content and structure were found to have a significant effect on performance. In Experiment II, 24 concrete operational and 24 formal operational children, all eighth graders, were tested on nine recursive and nonrecursive tasks varying in content. A significant interaction was obtained between developmental level and structure of the task. Analyses indicated that formal operational subjects performed better than concrete operational subjects on the recursive tasks, while there was no difference in performance on two of the three nonrecursive tasks. The results were interpreted to support the hypotheses that the ability to understand recursive structure requires formal operations.  
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Rethinking "Thinking about Thinking"

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## Rethinking "Thinking about Thinking"

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Recursive thinking is defined by Miller, Kessel, and Flavell (1970) as an indefinitely long nested series of representational acts. Miller et al. hypothesized a developmental sequence of recursive thinking which included the following structural formats: 1) thinking about contiguous people (contiguity), 2) thinking about action between people (action), 3) thinking about thinking (one-loop recursion), and 4) thinking about thinking about thinking (two-loop recursion). Using first to sixth graders' verbal descriptions of line drawings representing each of the four levels, Miller et al. found strong support for the orderly, predictable sequence of these levels.

As Miller et al. point out, the action items (the boy is thinking that the girl is talking to the father) and the one-loop items (the boy is thinking that the girl is thinking of the father) have the same syntactic structure, yet surprisingly the one-loop tasks are significantly more difficult than the action tasks. The difference, according to Miller et al., is between representational and motor or perceptual actions. Thinking as a representational action can have itself or another representational action as its own object, and thus be recursive, while talking as a motor action can only be sequential and chain-like, never hierarchical and nested.

Miller et al.'s interpretation raises several questions about content and structural differences in their tasks. Specifically, the tasks vary both in their structural nature (recursive versus nonrecursive) and in their specific contents (thinking versus talking). It is possible, however, to isolate these confounded factors by making "talking" into a recursive task, simply by

phrasing it as "talking about" rather than "talking to". In this form "the boy is talking about the girl talking about the father" is recursive and thus structurally equivalent to "the boy is thinking of the girl thinking of the father." Comparing these tasks permits an evaluation of content effects unconfounded by differences in their recursive nature. Recursive tasks involving other representations, such as "the boy is holding a picture of the girl holding a picture of the father", and combinations which mix contents but remain recursive, such as "the boy is thinking of the girl talking about the father" can be added to provide an even broader test of the importance of content effects.

The purpose of Experiment 1 was to test these content effects by contrasting the "thinking", "talking", and "picture" tasks. In addition, some children were given corrective feedback to evaluate the stability of their verbal responses.

## EXPERIMENT 1

### Method

#### Subjects

The subjects were 32 children from a suburban elementary school, four boys and four girls from each of grades two, four, six, and eight. Subjects were chosen randomly within sex from class rosters and included only Caucasians.

#### Materials

The materials were modeled closely after Miller et al., and consisted of 24 white poster board cards, each 11 x 14 inches (27.9 x 35.6 cm). Each card contained a cartoon-like figure representing the item. On each card thinking was represented by a scalloped cloud, talking by a smooth cloud, and a picture by a rectangular frame. Faces of a boy, a girl, a mother, and a father represented the characters. The nested clouds or frames and faces were colored in

brown, pink, blue, or yellow such that each nested level was easily distinguishable.

Eight types of task were used, with three parallel items for each task. The eight tasks consisted of one-loop and two-loop recursive tasks for "thinking", "talking", and "picture", a one-loop task of mixed content, in the form "thinking of talking about", and the action task "thinking of talking to" as used by Miller et al. Exact verbal descriptions of each of the 24 items are presented in Table 1.

#### Task and procedure

All subjects were tested individually and all sessions were tape-recorded. A pretraining period was used to assure the subjects' familiarity with the meaning of the stimulus materials. Each subject was shown and asked to identify sample cartoons representing talking, thinking, pictures, and the faces depicted in the items. The experimenter pointed out perceptual differences between these symbols and explained the difference in meaning to subjects who could not already demonstrate familiarity with the representations. When the experimenter was satisfied that the subject understood the representations, the subject was asked to describe a drawing of a boy thinking about a mother and a father.

After this pretraining, the 24 cards were successively placed on the table in front of the subject. The order of presentation was determined such that the first eight cards of the series consisted of one item representing each of the eight tasks. The same was true for cards 9 through 16 and for cards 17 through 24. The order of presentation within each series was randomly determined and was the same for all subjects. As the subjects responded to each card they could see none of the other cards. Each time the experimenter presented a card she asked, "What is the boy doing?". If the response was ambiguous the subject was asked to clarify the statement.

The subjects were randomly assigned to one of two feedback conditions.

In condition I, subjects were given the correct response after the first error was made. No further feedback was given. In condition II, subjects were corrected for all errors made in the first eight items, which included one item representing each of the eight different tasks.

### Analysis

Responses were scored from the tapes. The verbal structure of the response was the criterion for a correct answer. For example, correct responses for item 13 were "The boy is thinking about the girl thinking about the father" or "The boy is thinking of the girl thinking of the father". In contrast, incorrect responses were "The boy is thinking of the girl and the father" or "The boy is thinking of the girl and the girl is thinking of the father".

The preliminary analysis consisted of a 4(grades) by 2(feedback) analysis of variance with total number of correct responses over all 24 items as the dependent variable. The main analysis was based on a one-way repeated measures design with the eight tasks being the repeated factor. This one-way design was necessitated by the nature of the tasks used, which did not permit a completely crossed design. For this analysis number of correct responses on the three items of each task was used as the dependent variable. The  $\alpha$  level was set at .05 for all statistical tests.

### Results

The preliminary analysis indicated no significant effect for feedback,  $F(1,24) < 1$ , and no significant grade by feedback interaction,  $F(3,24) < 1$ . The effect for Grade was significant,  $F(3,24) = 3.62$ ,  $p < .05$ , with means of Grade 2 = 5.88, Grade 4 = 7.75, Grade 6 = 12.13, and Grade 8 = 15.63. Scheffe post hoc comparisons indicated that the only significant pairwise difference was between Grade 2 and Grade 8.

The means and standard deviations for number of correct responses for the eight tasks is presented in Table 2. The results of one-way repeated measures analysis showed a significant difference between tasks,  $F(7,217) = 14.17$ ,  $p < .05$ . Scheffe post hoc comparisons indicated that the "Picture" tasks (I and II) were significantly easier than either the "Talking" tasks (III and IV) or the "Thinking" tasks (V and VI). There was no significant difference between the "Talking" and "Thinking" tasks. One-loop recursive tasks (I, III and V) were significantly easier than two-loop recursive tasks (II, IV, and VI). Finally, the action task "Thinking of talking to" (VIII) was significantly easier than the one-loop thinking task (V), but there was no significant difference between the one-loop thinking task and the one-loop mixed content task (VII).

#### Discussion

The increasing performance between the second and eight grades is consistent with Miller et al.'s results. In addition, the feedback provided in this study had no significant effect upon the child's ability to describe the embedded sequences. These results suggest that the child's verbal response is sufficiently stable for use as a dependent measure in this type of study.

Clearly, the specific content of the recursive tasks has an important effect on the child's performance. Recursive sequences represented by a picture were easier to describe than those represented by talking or thinking. It may be that the symbol used in the picture tasks (the rectangular frame) is easier to learn and/or more meaningful to children than the scalloped and smooth balloons representing thinking and talking, though there appeared to be no differential effect in the pretraining.

The role of content can be clarified by further comparisons. The one-loop "thinking of thinking" tasks and the one-loop mixed content "thinking of

talking about" tasks are both recursive but differ in content, and these tasks were found to be equally difficult. The action task "thinking of talking to" and the one-loop mixed content task "thinking of talking to" are similar in content but differ in recursive structure, and the action task was found to be significantly easier. These results support Miller et al.'s conclusions about the importance of recursive structure, while eliminating the alternative hypothesis that "talking" tasks are easier than "thinking" tasks.

Finally, it was found, in accord with Miller et al., that the one-loop tasks were significantly easier than the two-loop tasks. Miller et al. suggest that these tasks resemble the logic of the hierarchy of classes, a construction of Piaget's (1970) stage of concrete operations. Further analysis, however, suggests to us that the single element "thinking of" can be thought of as an operation in the Piagetian sense. Recursive tasks which require the nesting of two or more of these elements (i.e., "thinking of thinking") would then represent operations on operations, the defining characteristic of Piaget's stage of formal operations. Non recursive tasks would include only the single element and would thus be described as concrete operational. The purpose of Experiment II was to test the hypothesis that concrete and formal operational children would perform equally well on nonrecursive tasks but that formal operational children would perform significantly better than concrete operational children on recursive tasks.

## EXPERIMENT II

### Method

#### Subjects

The subjects were eighth grade students from a suburban Milwaukee middle school. One hundred children were pretested on the "Test of Logical Thinking" (TOLT; Gray, 1973) and on the basis of their performance 24 formal operational children (12 males and 12 females) and 24 concrete operational children (12

males and 12 females) were selected from the original group for further testing. The 48 subjects ranged in age from 12.7 years to 15.5 years, with a mean age of 14.1 years.

### Tests and Materials

The TOLT (Gray, 1973), a paper and pencil group-administered test, was used to determine the developmental levels of the subjects. The TOLT is designed to assess the formal operations of exclusion, combinations, and proportions. Only the exclusion scale (12 items) was used in the present study. The items were constructed with reference to an extensive analysis of the logic of the operation. Thus the items are all logically analogous to a corresponding Piagetian physical task. The  $KR_{20}$  estimate of written test reliability on the scale was substantial, 0.88 for the exclusion scale. This indicates a great deal of internal consistency within the scale. Evidence of convergent and discriminant validity of the scale was mixed, but the scalability of the items was perfect.

The materials for the recursion tasks consisted of 27 cards identical in format to the cards of Experiment I. Three parallel items were constructed for each of nine tasks, representing combinations of nonrecursive, one-loop, and two-loop structures using the content of pictures, talking, and thinking. Exact verbal descriptions of each of the 27 items are presented in Table 1.

### Procedure

The instructions, pretraining, and procedures were identical to those of Experiment I, except that no corrective feedback was given. There were four orders of presentation of the 27 items, each given to three subjects within each developmental level and sex. Within each block of nine items each of the nine tasks was represented once.

### Scoring

On the TOLT a subject was scored as either correct or incorrect according

to his or her response on each item. The 12 items were grouped into four subscales: beginning concrete, complete concrete, beginning formal and complete formal. To be classified at a specific developmental level, a subject's answer pattern had to conform to the following criteria: a) at least two out of the three questions representing the specific subscale must have been answered correctly and b) at least two out of the three questions for each preceding subscale must have been answered correctly. The highest developmental level attained on the exclusion scale indicated the subject's level of cognitive development. A second scorer scored a random selected sample of 12 tests in order to assess scoring reliability. The scorers disagreed on only one item of the 144 items judged. Using  $K$ , a measure of agreement which depends upon observed marginal totals (Light, 1973), inter-rater reliability was 0.98 for the classification of subjects by developmental level.

The recursion items were scored from the tapes by two independent scorers. Inter-rater reliability for the correct/incorrect classification of each response was .98 using  $K$ . Each subject received nine scores, one for each of the nine tasks. Each of the nine scores ranged from zero to three. As in Experiment I, the verbal structure of a response served as an indicator of whether the subject correctly understood the item. Errors were assigned to four categories: cue, contiguity, chain, and recursion-plus-chain. Contiguity, chain and recursion-plus-chain errors were used as defined by Miller et al. A cuing error was defined as an incorrect classification of the representation (e.g. mistaking "thinking" for "talking"). Inter-rater reliability for the classification of errors was 0.97 using  $K$ .

### Analysis

Number of correct responses was used as the dependent variable. Three separate 2 (developmental level) x 2 (sex) x 3 (structure) split-plot analyses

of variance were performed, one for each of the content areas of Picture, Talking and Thinking. The  $\alpha$  level was set at .05 for all analyses.

### Results

Table 4 presents the means and standard deviations of items correct per task for developmental level, structure of tasks, and content area. The Picture and Thinking tasks produced similar results in the ANOVAS. In each analysis the main effect for development (Picture:  $F(1,44) = 18.94, p < .05$ ; Thinking:  $F(1,44) = 11.66, p < .05$ ), the main effect for structure (Picture:  $F(2,88) = 208.39, p < .05$ ; Thinking:  $F(2,88) = 306.42, p < .05$ ) and the structure  $\times$  development interaction (Picture:  $F(2,88) = 15.53, p < .05$ ; Thinking:  $F(2,88) = 10.47, p < .05$ ) were significant. All tests of within subjects effects were significant using conservative degrees of freedom (Kirk, 1968). The main effect for sex was not significant for either content area ( $F(1,44) < 1$  for each). The Scheffe post hoc comparison method was used to analyze the interactions. For each of the content areas, the following contrasts were tested for significance: (1)  $[(FO_{non} - CO_{non})] - [(FO_{1L} - CO_{1L})]$ , that is, the difference between formal operational and concrete operational subjects on the nonrecursive tasks ( $FO_{non} - CO_{non}$ ) was compared to the difference between formal operational and concrete operational subjects on the one-loop tasks ( $FO_{1L} - CO_{1L}$ ); 2)  $[(FO_{non} - CO_{non})] - [(FO_{2L} - CO_{2L})]$ ; and 3)  $[(FO_{1L} - CO_{1L})] - [(FO_{2L} - CO_{2L})]$ . For both Picture and Thinking content areas contrasts 1 and 2 were significant at the .05 level. Note that perfect scores were received by both the concrete operational and formal operational subjects on the non-recursive Picture and Thinking tasks. Contrast 3 was not significant in either content area.

For the Talking task, there was a significant main effect for developmental level ( $F(1,44) = 14.72, p < .05$ ) and a significant main effect for structure

( $F(2,88) = 81.25, p < .05$ ). The test of within subjects effects was significant using conservative degrees of freedom (Kirk, 1968). There was no significant structure x development interaction ( $F(2,88) < 1$ ) nor was the main effect for sex significant ( $F(1,44) < 1$ ). The Scheffe post hoc comparison technique was used to test the three possible pairs of means for the structure factor. At the .05 level, the nonrecursive tasks were significantly easier than the one-loop tasks and also significantly easier than the two-loop tasks. There was no significant difference between the one-loop and the two-loop tasks. Since only two levels were involved in the significant main effect for development, there was no need for post hoc analyses. The formal operational subjects scored higher on this task than did the concrete operational subjects.

Table 5 presents the mean number of errors by developmental level, structure of tasks, and task content, categorized according to type of error. Note that the only type of error possible on nonrecursive tasks is a cuing error. On the Picture and Thinking tasks, the major difference between concrete operational and formal operational subjects appears to be due to the relatively large number of contiguity errors made by the concrete operational subjects. On the Talking tasks, the concrete operational subjects' poorer performance seems to be due to both contiguity and cuing errors.

#### Discussion

The results for the Picture and Thinking tasks directly support the hypotheses of Experiment II. For both content areas, concrete and formal operational children performed equally well on the nonrecursive tasks. Both groups of children obtained perfect scores of 3.00 items correct on these tasks. In addition, for both content areas, the formal operational children performed better than the concrete operational children on the one-loop and

and the two-loop recursion tasks. According to the analysis presented previously, nonrecursive tasks are first order operations, one-loop and two-loop recursion tasks are second-order operations. Thus the results for the Picture and Thinking tasks provide strong support for the interpretation that the nonrecursive tasks require concrete operations and the one-loop and two-loop tasks require formal operations for solution.

Inspection of the errors made on these tasks indicates that the differences between concrete and formal children are due largely to contiguity errors ("the boy is thinking about the girl and the mother"). This error is essentially a failure to consider the operations embedded within the first operation, substituting a description of only the figures embedded within the first operation. This type of error seems completely consistent with the concrete operational abilities of these children, and provides additional indirect support for the hypotheses of Experiment II.

The results for the Talking tasks support the hypothesis that formal operational children would perform better than concrete operational children on the one-loop and the two-loop tasks. However the results fail to support the hypothesis that concrete and formal operational children would perform equally well on the nonrecursive tasks. The formal operational children performed significantly better than the concrete operational children on the nonrecursive Talking task.

Inspection of the errors made on the Talking tasks indicates that, as on the Picture and Thinking tasks, concrete children made many more contiguity errors than formal children. However, unlike the Picture and Thinking tasks, concrete and formal operational children both made cuing errors, with concrete children in particular making a large number of these errors. In a cuing error, the child mistakenly interprets the representational symbol. For the Talking

items this almost always took the form of substituting "talking to" for "talking about". The frequency of these errors clearly accounts for the significantly poorer performance of the concrete operational children. These errors must be accounted for in part by the post hoc explanation of inadequate pretraining, though there was no indication during the actual pretraining that this would be a problem. In addition, a wrong answer ("talking to") was more readily available for the Talking tasks than for the Pictures or Thinking. It is likely that more complete pretraining on this particular set of items would reduce this source of error considerably.

In sum, the two experiments presented here clarify the role of content and structural factors in recursive thinking. In addition, the studies have demonstrated that the skills involved in this particular form of social cognition are not complete by middle childhood but develop well into adolescence, and, more importantly, that the changes are consistent with concurrent changes in intellectual development.

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TABLE 1

Verbal descriptions of the items used in Experiments I and II

| Item type<br>and number     | Description                                                                                              |
|-----------------------------|----------------------------------------------------------------------------------------------------------|
| I. One-loop picture tasks   |                                                                                                          |
| 1.                          | The boy is holding a picture of the mother holding a picture of the father                               |
| 2.                          | The boy is holding a picture of the father holding a picture of the girl                                 |
| 3.                          | The boy is holding a picture of the father holding a picture of the mother                               |
| II. Two-loop picture tasks  |                                                                                                          |
| 4.                          | The boy is holding a picture of the father holding a picture of the girl holding a picture of the mother |
| 5.                          | The boy is holding a picture of the mother holding a picture of the father holding a picture of the girl |
| 6.                          | The boy is holding a picture of the girl holding a picture of the father holding a picture of the mother |
| III. One-loop talking tasks |                                                                                                          |
| 7.                          | The boy is talking about the father talking about the girl                                               |
| 8.                          | The boy is talking about the father talking about the mother                                             |
| 9.                          | The boy is talking about the girl talking about the mother                                               |
| IV. Two-loop talking tasks  |                                                                                                          |
| 10.                         | The boy is talking about the girl talking about the father talking about the mother.                     |
| 11.                         | The boy is talking about the father talking about the mother talking about the girl                      |
| 12.                         | The boy is talking about the mother talking about the girl talking about the father                      |

## V. One-loop thinking tasks

- 13. The boy is thinking of the girl thinking of the father
- 14. The boy is thinking of the mother thinking of the girl
- 15. The boy is thinking of the mother thinking of the father

## VI. Two-loop thinking tasks

- 16. The boy is thinking of the girl thinking of the mother thinking of the father
- 17. The boy is thinking of the mother thinking of the girl thinking of the father
- 18. The boy is thinking of the father thinking of the mother thinking of the girl

## VII. One-loop mixed content tasks

- 19. The boy is thinking of the father talking about the mother
- 20. The boy is thinking of the girl talking about the mother
- 21. The boy is thinking of the girl talking about the father

## VIII. Action tasks

- 22. The boy is thinking of the girl talking to the mother
- 23. The boy is thinking of the girl talking to the father
- 24. The boy is thinking of the mother talking to the girl

## IX. Non recursive picture tasks

- 25. The boy is holding a picture of the girl
- 26. The boy is holding a picture of the mother
- 27. The boy is holding a picture of the father

## X. Non recursive talking task

- 28. The boy is talking about the girl
- 29. The boy is talking about the mother
- 30. The boy is talking about the father

XI. Non recursive thinking tasks

- 31. The boy is thinking of the girl
- 32. The boy is thinking of the mother
- 33. The boy is thinking of the father

Note: Tasks I-VIII were used in Experiment I.

Tasks I-VI, and IX-XI were used in Experiment II.

TABLE 2

Mean and standard deviation for number of correct responses to the eight tasks

| Task |                        | $\bar{X}$ | SD   |
|------|------------------------|-----------|------|
| I    | One-loop picture       | 1.906     | 1.04 |
| II   | Two-loop picture       | 1.375     | 1.05 |
| III  | One-loop talking       | .938      | 1.25 |
| IV   | Two-loop talking       | .719      | 1.00 |
| V    | One-loop thinking      | 1.094     | 1.09 |
| VI   | Two-loop thinking      | .938      | 1.27 |
| VII  | One-loop mixed content | 1.219     | 1.22 |
| VIII | One-loop action        | 2.094     | .84  |

TABLE 4

Means and standard deviations for number of correct responses by developmental level, structure of task, and task content.

| Task<br>Content | Developmental<br>Level |    | Structure of Task |          |          |       |
|-----------------|------------------------|----|-------------------|----------|----------|-------|
|                 |                        |    | Non<br>recursive  | One-loop | Two-loop | Total |
| Picture         | Concrete               | X  | 3.00              | .211     | -.17     | 1.31  |
|                 | Operational            | SD | .00               | .72      | -.64     | .18   |
|                 | Formal                 | X  | 3.00              | 1.54     | 1.21     | 1.92  |
|                 | Operational            | SD | .00               | 1.14     | 1.28     | .77   |
|                 | Total                  | X  | 3.00              | .88      | .69      |       |
|                 |                        | SD | .00               | 1.35     | 1.28     |       |
| Talking         | Concrete               | X  | 2.04              | .04      | .04      | .71   |
|                 | Operational            | SD | 1.37              | .20      | .20      | .49   |
|                 | Formal                 | X  | 2.75              | 1.08     | .83      | 1.50  |
|                 | Operational            | SD | .85               | 1.38     | 1.24     | .87   |
|                 | Total                  | X  | 2.40              | .56      | .44      |       |
|                 |                        | SD | 1.18              | 1.23     | .93      |       |
| Thinking        | Concrete               | X  | 3.00              | .08      | .04      | 1.04  |
|                 | Operational            | SD | .00               | .41      | .20      | .04   |
|                 | Formal                 | X  | 3.00              | 1.00     | .96      | 1.65  |
|                 | Operational            | SD | .00               | 1.32     | 1.23     | .70   |
|                 | Total                  | X  | 3.00              | .54      | .50      |       |
|                 |                        | SD | .00               | 1.14     | .98      |       |

TABLE 5

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Mean number of errors for each developmental level, structure of task, and task content

| Task Content | Developmental Level | Structure of Task | Type of Error |            |       |                      | Total |
|--------------|---------------------|-------------------|---------------|------------|-------|----------------------|-------|
|              |                     |                   | Cue           | Contiguity | Chain | Recursion-plus-chain |       |
| Picture      | Concrete            | Non recursive     | .00           | --         | --    | --                   | .00   |
|              |                     | One-loop          | .04           | .71        | 1.96  | .08                  | 2.79  |
|              |                     | Two-loop          | .00           | .75        | 1.96  | .13                  | 2.84  |
|              |                     | Total             | .04           | 1.46       | 3.92  | .21                  | 5.63  |
|              | Formal              | Non recursive     | .00           | --         | --    | --                   | .00   |
|              |                     | One-loop          | .00           | .04        | 1.42  | .00                  | 1.46  |
|              |                     | Two-loop          | .00           | .04        | 1.72  | .04                  | 1.80  |
|              |                     | Total             | .00           | .08        | 3.14  | .04                  | 3.26  |
|              | Talking             | Non recursive     | .96           | --         | --    | --                   | .96   |
|              |                     | One-loop          | .67           | .88        | 1.41  | .00                  | 2.96  |
|              |                     | Two-loop          | .58           | 1.00       | 1.38  | .00                  | 2.96  |
|              |                     | Total             | 2.21          | 1.88       | 2.79  | .00                  | 6.88  |
|              | Thinking            | Non recursive     | .25           | --         | --    | --                   | .25   |
|              |                     | One-loop          | .29           | .04        | 1.58  | .00                  | 1.91  |
|              |                     | Two-loop          | .33           | .13        | 1.71  | .00                  | 2.17  |
|              |                     | Total             | .87           | .17        | 3.29  | .00                  | 4.33  |
| Thinking     | Concrete            | Non recursive     | .00           | --         | --    | --                   | .00   |
|              |                     | One-loop          | .00           | 1.04       | 1.88  | .00                  | 2.92  |
|              |                     | Two-loop          | .00           | 1.29       | 1.67  | .00                  | 2.96  |
|              |                     | Total             | .00           | 2.33       | 3.55  | .00                  | 5.88  |
|              | Formal              | Non recursive     | .00           | --         | --    | --                   | .00   |
|              |                     | One-loop          | .00           | .13        | 1.88  | .00                  | 2.01  |
|              |                     | Two-loop          | .00           | .13        | 1.92  | .00                  | 2.05  |
|              |                     | Total             | .00           | .26        | 3.80  | .00                  | 4.06  |
|              | Talking             | Non recursive     | .96           | --         | --    | --                   | .96   |
|              |                     | One-loop          | .67           | .88        | 1.41  | .00                  | 2.96  |
|              |                     | Two-loop          | .58           | 1.00       | 1.38  | .00                  | 2.96  |
|              |                     | Total             | 2.21          | 1.88       | 2.79  | .00                  | 6.88  |

Note: -- means this type of error not possible for this task